PUMP PLUNGER IMPROVEMENTS AT KOBE INC.

A company must continually update its product to remain competitive. Even in such seemingly stable equipment as positive-displacement pumps, the designs do not remain unchanged for long.

Pumping large quantities of oil at high pressure, while running twenty-four hours a day, requires a pump that is made to exacting specifications. A pump of this type is made by Kobe, Inc., a company founded in 1923 by C. J. Coberly and located in Huntington Park, California. Kobe uses this pump in their hydraulic oil well pumping system. In this system a prime mover operates a positive displacement triplex pump to supply a continuous flow of power fluid to a reciprocating hydraulic engine and producing pump at the bottom of the well. The engine and producing pump at the bottom of the well are an integral unit. The exhausted power oil is mixed with the crude oil production and is pumped into a storage tank. After sand and other impurities have settled in the tank, a triplex pump (a three cylinder, positive displacement type) will use some of the crude oil as power fluid.

A unique feature of the Kobe triplex pump (Exhibit 1) is the precision metal-to-metal fit between the plunger and liner. This fit results in a higher efficiency than can be obtained by using packings. When the liners are worn enough to cause excessive leakage, they are removed and replaced by rehoned assemblies.

Exhibit 2 shows the plunger and liner in the cylinder block. On each plunger downstroke, the differential pressure across the left ball valve opens it and oil is admitted to the cylinder. On the upstroke, the ball valve on the right is opened by differential pressure and the high pressure oil is exhausted.

To pump crude oil from today's deep wells requires oil pressures up to 30,000 psi. A pump which operates reliably and continuously at these pressures must be well designed. In order for Kobe to achieve this reliable performance in their pumps it has been necessary for them to refine their design over a number of years. Before a change of design is incorporated, an extensive testing program must be completed to determine exactly what the consequences of the change will be. These testing programs, which extend over long periods, are expensive and cannot be undertaken if it is not profitable to do so. Because of the wide variety of conditions under which their pumps operate, the testing programs yield only "no" answers, i.e., they can tell if a change is bad, but they cannot prove that it is good.

As one example of the refinement of the pump, the development of the plunger and liner from 1943 to 1967 will be considered. The evolution of the plunger and liner can be followed by referring to Exhibit 3, a listing of the changes made in these parts, and to Exhibits 4 through 10, detailed drawings of

 Prepared in the Design Division, Department of Mechanical Engineering, by Robert Martin, with support from the National Science Foundation. The assistance of Mr. R. F. McArthur is gratefully acknowledged.

the parts. Exhibits 4 through 6 are drawings of the plunger; Exhibit 4, May 1, 1944, is the original plunger drawing. Three drawings are omitted between Exhibits 5 and 6. A sequence of liner drawings is shown in Exhibits 7 through 9; Exhibit 7, April 21, 1943, is the original liner drawing. Three drawings are omitted between Exhibits 7 and 8 and one is omitted between Exhibits 8 and 9. Exhibit 10 is a plunger and liner subassembly drawing which Kobe uses to specify the allowable clearance between the plunger and liner.

The story of only one of these design changes will be considered in detail; that is the addition of an o-ring seal between the plunger and liner to reduce leakage (Exhibit 3, liner change 12). Kobe had produced many of their triplex pumps and they were performing satisfactorily in the field; however one of their field representatives, Mr. John Smith,* received a complaint about leakage in the pump. The problem was not an obvious one. The only time that leakage of oil was noticeable was when mechanics pulled the handhole covers to make repairs or to inspect the interior of the spacer block area. The parts in this area would be coated with crude oil and even a little of this makes an ugly mess.

The complaint was passed from the field representative to the sales department and from there to engineering. A project engineer, Mr. Harry Knowles,* was assigned to consider the possibilities of decreasing the leakage. From the start it seemed that the only workable solution to the problem would be the addition of a seal. Harry then considered the problems that would be encountered in adding a seal to the plunger and liner assembly.

The following are some of the questions that he had to answer. What type of seal should be used? Where should it be located? What changes will have to be made in manufacturing procedures? Would the inclusion of a seal improve the efficiency of the unit? What type of testing program will be needed?

In a new unit, the leakage is an extremely small percentage of the total volume being pumped; thus the performance of the pump would not be improved by the addition of a seal. Due to the expense of testing, it was not considered profitable to include the seal at this time.

Eventually enough complaints were received to merit the addition of an o-ring, but by this time two other design changes had been proposed. Now one testing program could be used to evaluate all three changes. The other changes made at the same time were shortening of the overall liner length and reduction of the 15^{o} level on the lower end of the liner.

*Fictitious name.

EXHIBITS, ECL 100

Exhibit 1	Kobe Triplex Pump
Exhibit 2	Cylinder Block Assembly (drawing No. D-37586)
Exhibit 3	Chronological List of Plunger and Liner Changes 1943-1967
Exhibit 4	Plunger, Floating (drawing) dated 6-14-44
Exhibit 5	Plunger, Floating (drawing) dated 3-24-48
Exhibit 6	Plunger, Floating (drawing) dated u-29-48
Exhibit 7	Liner, Cylinder (drawing) dated 4-21-43
Exhibit 8	Liner, Cylinder (drawing) dated 3-7-62
Exhibit 9	Liner (drawing) dated 11-21-62
Exhibit 10	Plunger and Liner Sub-Assembly (drawing) dated 12-27-54

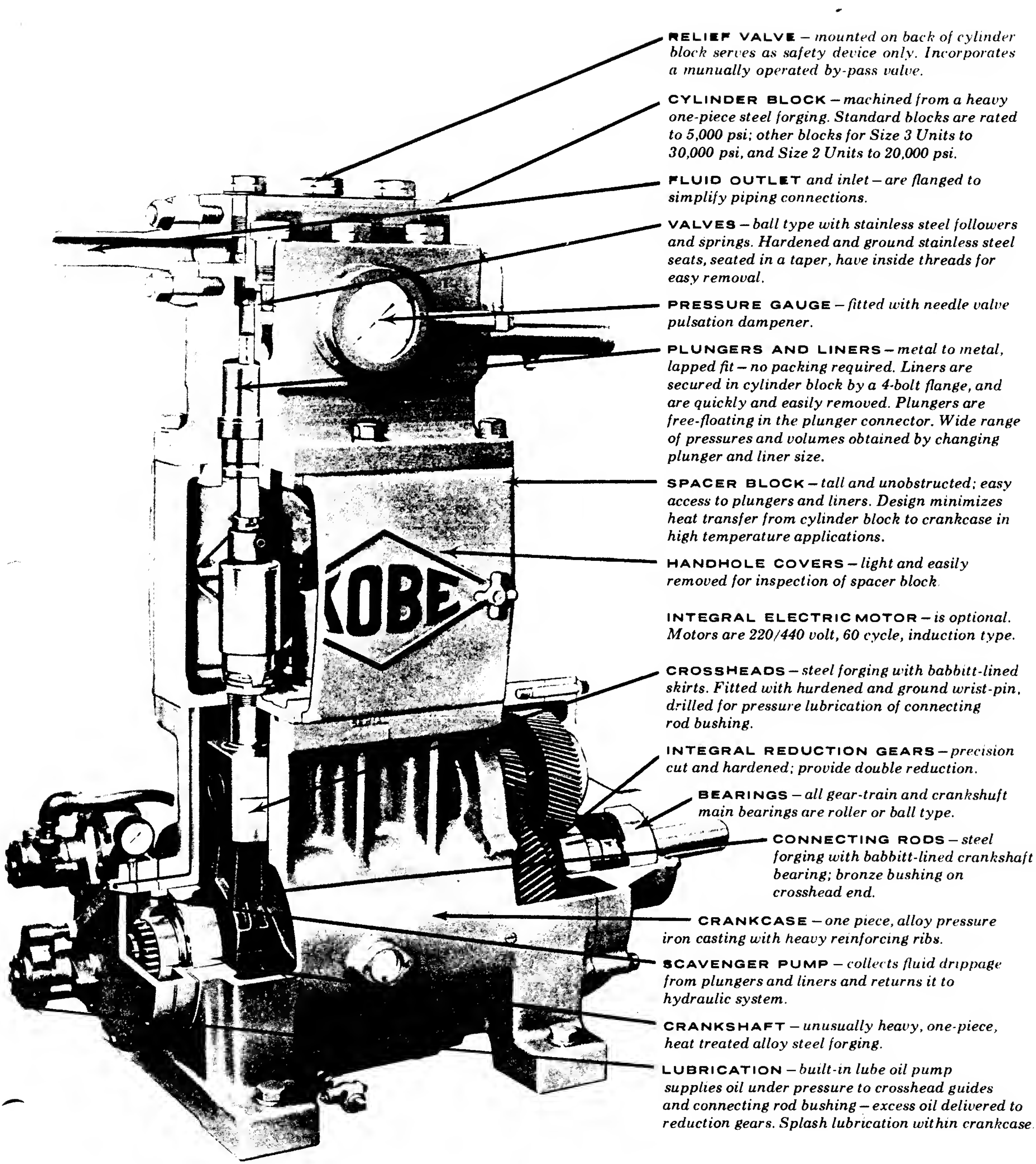
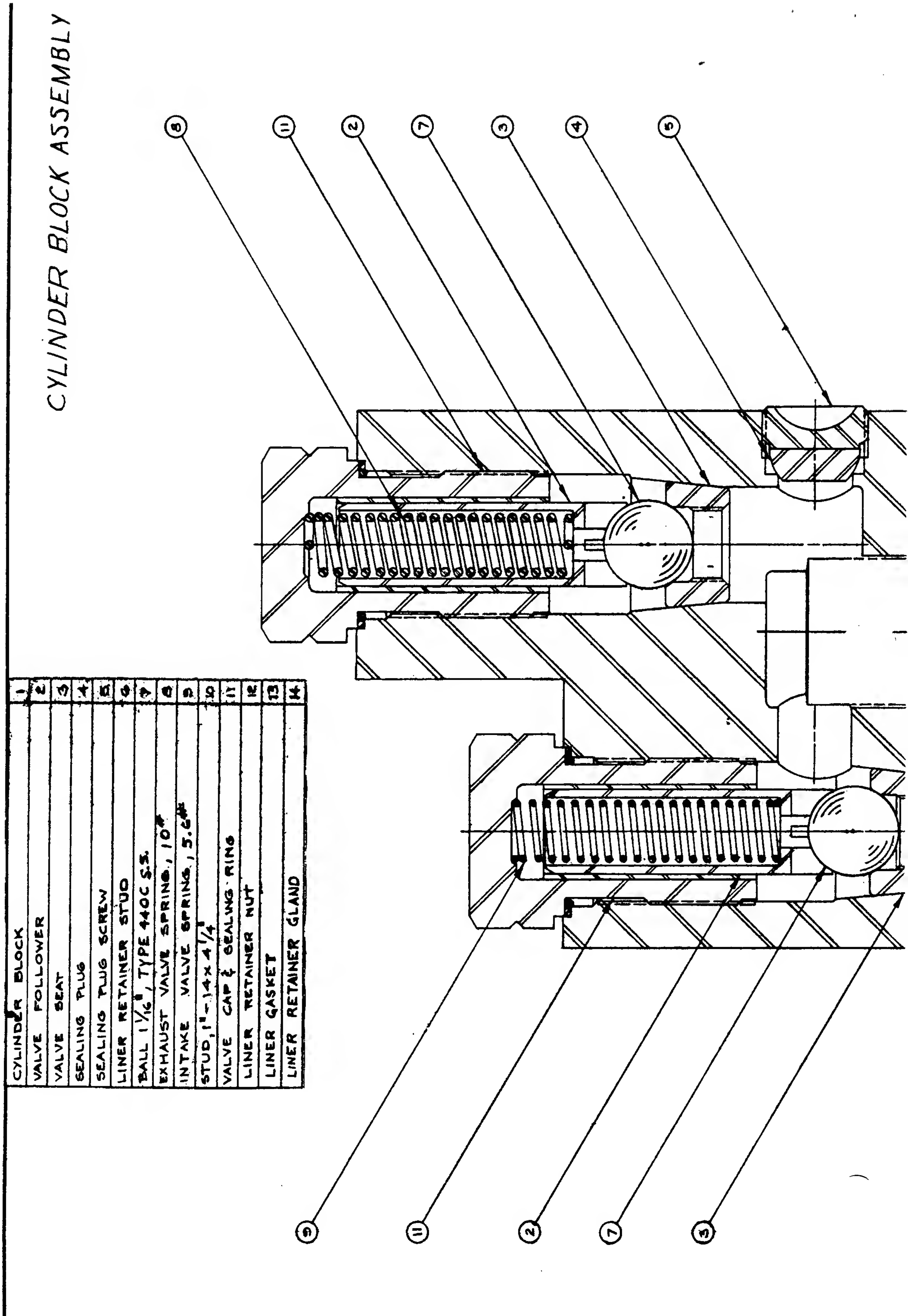
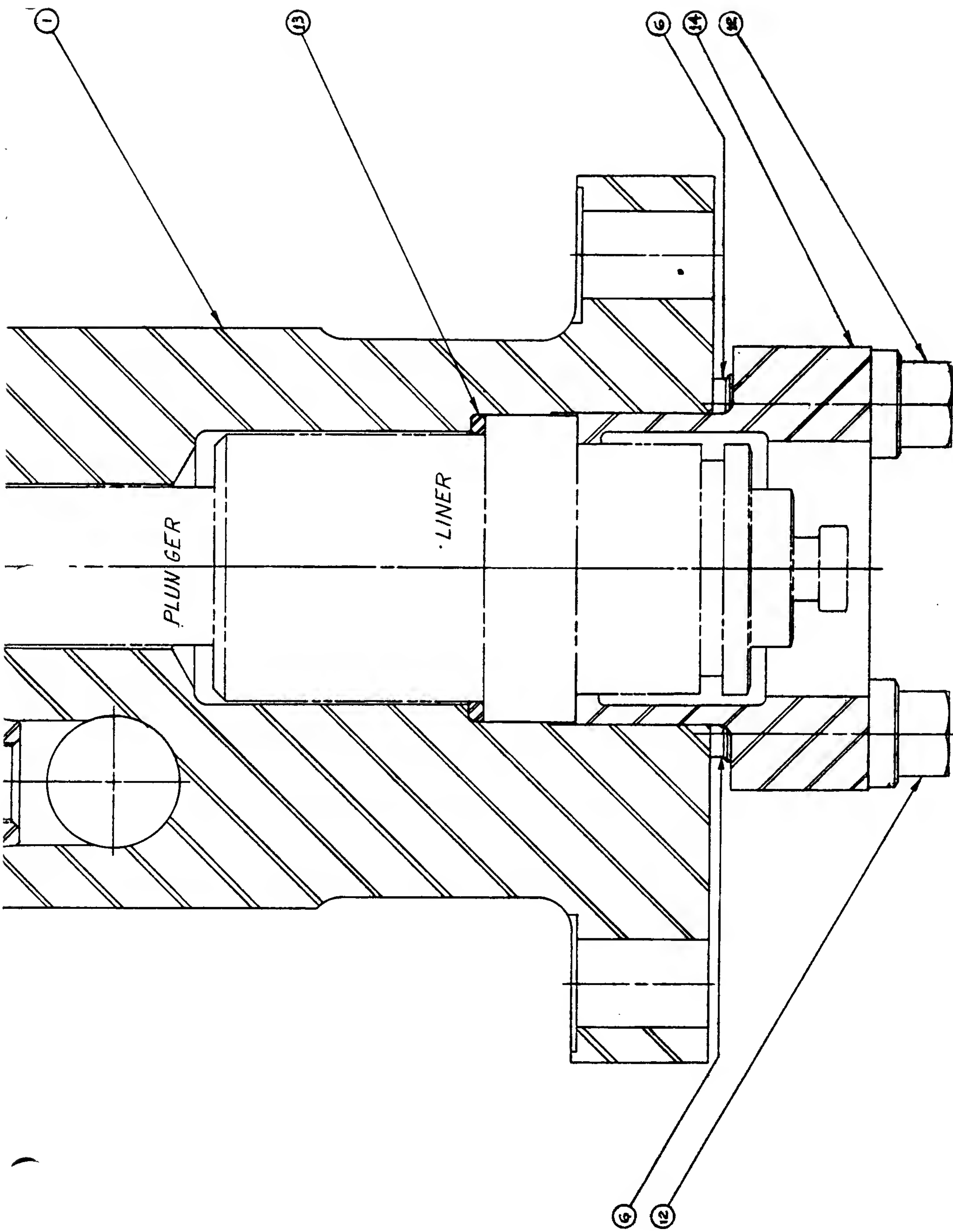

RELIEF VALVE – mounted on back of cylinder block serves as safety device only. Incorporates a munually operated by-pass valve.
CYLINDER BLOCK – machined from a heavy one-piece steel forging. Standard blocks are rated to 5,000 psi; other blocks for Size 3 Units to 30,000 psi, and Size 2 Units to 20,000 psi.
FLUID OUTLET and inlet – are flanged to simplify piping connections.
VALVES – ball type with stainless steel followers and springs. Hardened and ground stainless steel seats, seated in a taper, have inside threads for easy removal.
PRESSURE GAUGE – fitted with needle valve pulsation dampener.
PLUNGERS AND LINERS – metal to metal, lapped fit – no packing required. Liners are secured in cylinder block by a 4-bolt flange, and are quickly and easily removed. Plungers are free-floating in the plunger connector. Wide range of pressures and volumes obtained by changing plunger and liner size.
SPACER BLOCK – tall and unobstructed; easy access to plungers and liners. Design minimizes heat transfer from cylinder block to crankcase in high temperature applications.
HANDHOLE COVERS – light and easily removed for inspection of spacer block.
KOBE
INTEGRAL ELECTRIC MOTOR – is optional. Motors are 220/440 volt, 60 cycle, induction type.
CROSSHEADS – steel forging with babbitt-lined skirts. Fitted with hurdened and ground wrist-pin, drilled for pressure lubrication of connecting rod bushing.
INTEGRAL REDUCTION GEARS – precision cut and hardened; provide double reduction.
BEARINGS – all gear-train and crankshuft main bearings are roller or ball type.
CONNECTING RODS – steel forging with babbitt-lined crankshaft bearing; bronze bushing on crosshead end.
CRANKCASE – one piece, alloy pressure iron casting with heavy reinforcing ribs.
SCAVENGER PUMP – collects fluid drippage from plungers and liners and returns it to hydraulic system.
CRANKSHAFT – unusually heavy, one-piece, heat treated alloy steel forging.
LUBRICATION – built-in lube oil pump supplies oil under pressure to crosshead guides and connecting rod bushing – excess oil delivered to reduction gears. Splash lubrication within crankcase.

Exhibit 2 Cylinder Block Assembly (drawing No. D-37586)



1	CYLINDER BLOCK
2	VALVE FOLLOWER
3	VALVE SEAT
4	SEALING PLUG
5	SEALING PLUG SCREW
6	LINER RETAINER STUD
7	BALL 1 1/16", TYPE 440C S.S.
8	EXHAUST VALVE SPRING, 10#
9	INTAKE VALVE SPRING, 5.6#
10	STUD, 1"-14 x 4 1/4"
11	VALVE CAP & SEALING RING
12	LINER RETAINER NUT
13	LINER GASKET
14	LINER RETAINER GLAND


1
13
6
14
PLUNGER
LINER
6
12

	Date	Liner Changes	Plunger Changes
	June 1944		1) Ends of plunger center-drilled (P1) 2) 5^{o} chamfer on left-hand end eliminated 3) Tolerance and nominal diameters changed on grinding operation (P3) 4) Tolerance and nominal diameters changed on lap before plating (P4) 5) Material option listed (P5)
	Dec. 1944		6) Tolerance and nominal diameters changed on machine finishing operation (P6) 7) Tolerance and nominal diameters changed on grinding operation (P7) 8) Material specified to be NE 9445 steel
See Exhibit 7	Feb. 1945	1) Groove added to right-hand end of liner (L1)	
See Exhibit 7	Oct. 1945	2) Break all sharp edges O.D.-I.D. .005-.015R (L2)	
	Nov. 1945		9) Added 5^{o} chamfer to left-hand end
	Dec. 1945		10) Three finishing operations eliminated (P10)
See Exhibit 7	Feb. 1946	3) 45^{o} chamfer added to left-hand end (L3)	
See Exhibit 5	March 1946		11) Chamfer at right-hand end removed (P11) 12) 5^{o} chamfer on left-hand end extended from 3/32" to 3/16"
See Exhibit 7	Oct. 1946	4) Increased plunger clearance on two sizes (L4)	13) Material specified to be NIT EZ Kobe. See Exhibit 5
	Dec. 1946	5) Overall length of liner increased 1/16" 6) Tolerance on overall length increased (L6) 7) Bead seat moved 1/16" closer to left-hand end (L7)	

	Date	Liner Changes	Plunger Changes
See Exhibit 3	Feb. 1947		14) Center drill on both ends increased from 1/8" to 9/64"
			15) O.D. tolerance increased (P15)
			16) Break right-hand end comer at .020 R instead of .010 R
			17) Break left-hand end at .020 R instead of .005 R
	March 1947	8) Added Cadmium plate (L8)	
See Exhibit 5	Sept. 1947		18) Thickness of commercial chrome plate decreased (P18)
See Exhibit 5	March 1948		19) Chamfer on left-hand end reduced from 3/16" to 1/8"
	April 1948	9) Changed tolerance on location of bead seat (L9)	
	Jan. 1949		20) Increased minimum material hardness from 15N-93.5 to 15N-94.5
	July 1949	10) Removed some liner sizes (L10)	21) Removed some plunger sizes (L10)
	March 1951	11) Decreased plunger clearance on 3/4" size (L11)	
See Exhibit 8	Dec. 1954	12) Added o-ring groove (L12)	
		13) Overall length of liner was shortened 7/32"	
		14) 15^{o} chamfer on right-hand end shortened (L14)	
See Exhibit 8	Jan. 1955	15) Added lube grooves to 1-3/8" size (L15)	
	April 1958	16) Increased tolerance on right-hand end O.D. (L16)	
	Feb. 1962	17) O.D. of center portion increased (L17)	
		18) Tolerance on right-hand end O.D. increased (L18)	
	Nov. 1962	19) Lube grooves on 1-3/8" size eliminated (L19)	
See Exhibit 10	June 1963	20) Plunger clearances changed (L20)	

	Date	Liner Changes	Plunger Changes
See Exhibit 6	Dec. 1965		22) Changed end detail on right-hand end (P22)
See Exhibit 6	Nov. 1966		23) Changed end detail on left-hand end (P23)
See Exhibit 9	July 1967	21) Removed beat seat (L21)	

Notes

(L1) Dirt and corrosion from crude oil and gasket squeeze sometimes make liner removal from the cylinder block difficult. The addition of the 1/4" groove overcame this difficulty by allowing the use of a pinch bar or similar implement.

(L2) Facilitated manufacturing operations.

(L3) The chamfer increased axial clearance between the upper end of the liner and the end of the bore in the cylinder block into which the liner fits. After being in service, it occasionally is necessary to resurface the bead seat shoulder on the liner or the mating shoulder in the cylinder block or both. Having greater initial axial clearance permits refacing these surfaces more often with less risk of interference at the upper end of the liner.

(L4) Facilitated manufacturing operations.

(L6) Due to the 15^{o} level on the lower end, the overall length of the liner varies with the diameter of the bore. The smallest bore size liner (3/4") has the greatest length and the largest bore size liner (2-1/8") has the shortest length. Changing the overall length tolerance from +1/64" to +0/-3/16" permitted all size liners to be made from the same block and permitted reboring small sizes to larger sizes.

(L7) Moving the bead seat closer to the upper end reduced the chance of interference between the upper end of the liner and the end of the bore in the cylinder block into which the liner fits when one or both bead seat shoulders have been refaced.

(L8) This improved appearance and protected against corrosion during storage and shipment.

(L9) The tolerance was +0/-1/64"; changed to +1/64". This facilitated manufacturing operations.

(L10) See P21.

(L11) Clearance was 0.0004/0.0005"; changed to 0.0003/0.0005". This facilitated manufacturing operations.

(L12) The groove was added to minimize plunger leakage. Even without an o-ring, the leakage in a new unit is an extremely small percentage of the total volume being pumped; but the leakage increases with wear and even a small amount of crude oil makes an ugly mess.

(L14) The change of the 15^{o} level allowed all size liners to be the same length. Length tolerances can now be more closely controlled.

(L15) The lube grooves were added in an attempt to lengthen the already long service life of the plungers and liners. Because of the added cost this was done to only one size until it could be evaluated through field testing. The 1-3/8" size was selected because it had the greatest usage.

Notes

(L16) The diameter was specified to be 2.970/2.966"; changed to 2.970/2.960". This facilitated manufacturing operations.

(L17) The diameter was 3.345/3.341"; changed to 3.368/3.364". The center portion of the liner O.D. is the aligning portion. The increase in this diameter assured better center to center relationship of the three liners in any given cylinder block.

(L18) Tolerance was +0.002"; changed to +0.005". This facilitated manufacturing operations.

(L19) Eight years of testing were unable to demonstrate improved performance so the grooving was discontinued.

(L20) Clearance was increased on sizes smaller than 1-1/2" and decreased on sizes larger than 1-5/8". Inserted in Exhibit 10 is a table of clearances specified on a drawing dated April 22, 1952.

(L21) The bead seat was eliminated in favor of a flat shoulder. For many years the triplex used a fiber gasket as a seal between the liner shoulder and the mating shoulder in the cylinder block. This arrangement worked satisfactorily providing the liner nut, which retained the liner in the cylinder block, was tightened sufficiently. However, this was difficult to accomplish because most of the effort expended in torqueing the liner nut was used in overcoming friction in the large threads on the liner nut. When not sufficiently tightened, leakage through the gasketed joint resulted in fluid cutting on one or both sealing surfaces necessitating a shut down for repairs.

(P1) Shortens lathe set-up time for finishing operations.

(P3) Tolerance was +.0002/-.0000; changed to +.0005. All nominal diameters were decreased. These changes facilitated manufacturing operations.

(P4) Tolerance was +.0004/-.0000; changed to +.0000/-.0004. This change also made manufacturing easier.

(P5) Material was specified as SAE 4140; changed to SAE 4140 or NE 9445. SAE 4140 became unobtainable during the national emergency days of World War II, so NE 9445 was specified as an alternate.

(P6) Tolerance was +.002; changed to +.005. This facilitated manufacturing operations.

(P7) Tolerance was +.0005; changed to +.002/-.000. This change made manufacturing easier.

(P10) Only the final lapping operation was specified. At about this time two separate engineering divisions were established, General Engineering and Production Engineering. Since this division, only final functional dimensions and notations are shown on General Engineering drawings.

(P11) Replaced by 0.010 radius. The purpose of this change was to reduce chromium buildup which occurs on sharp corners during the electroplating operation.

(P15) Tolerance was +.0003/-.0000; changed to +.001/-.000. This change reduced manufacturing costs. It was not necessary to hold closer tolerances because the plunger and liner are mated.

Notes

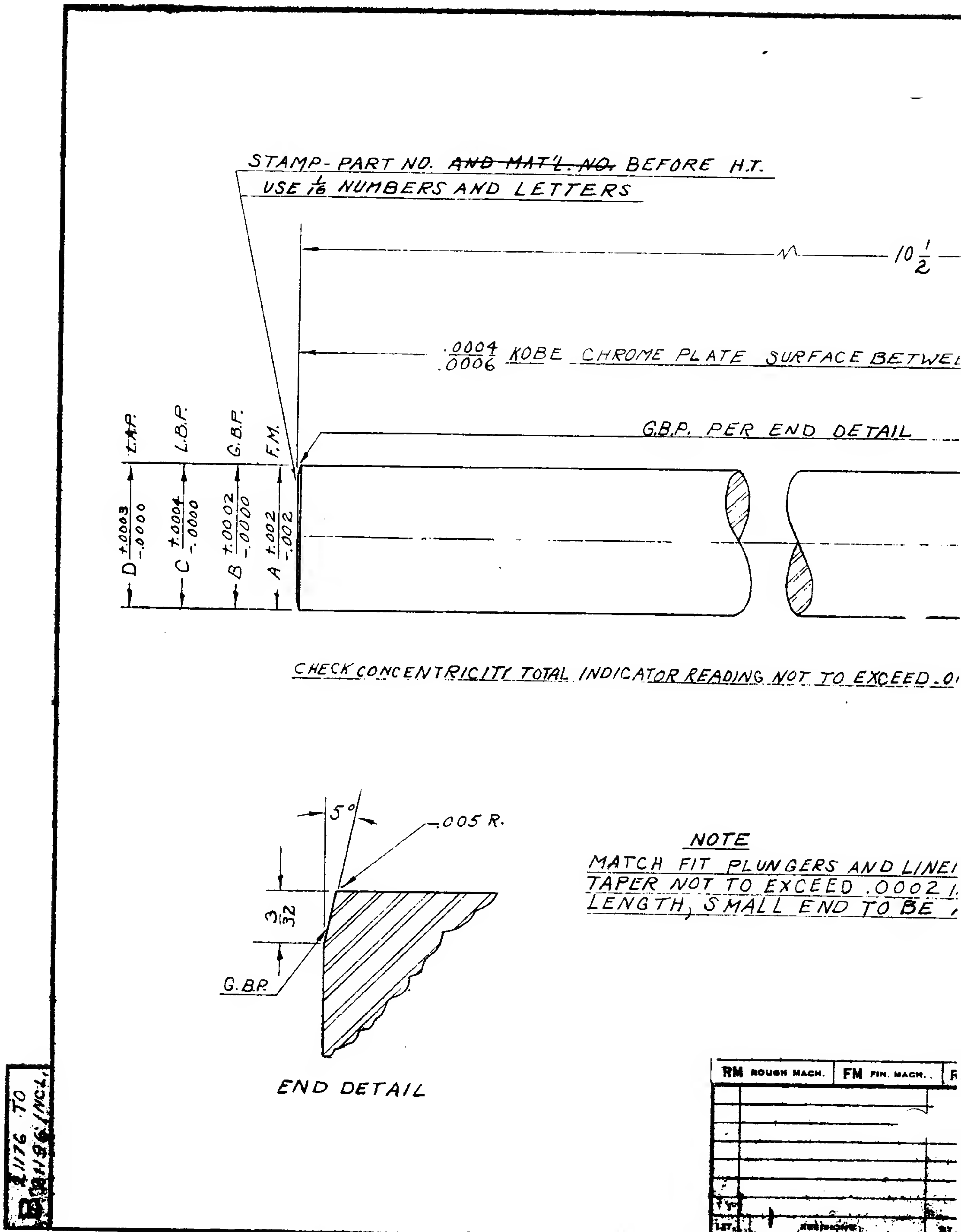
(P18) Thickness was .003/.005; changed to .0015/.0020. The "commercial chrome plated" type of plunger received no machining operations subsequent to chrome plating other than a small amount of lapping. The "Kobe chrome plated" type is ground and lapped or honed after chrome plating to obtain proper specifications. The reduction in thickness reduced cost, improved finish, and gave closer control on size. The "commercial" type was discontinued in 1952.

(P21) Plunger and liner sizes 1-1/16", 1-3/16", 1-5/16", 1-7/16", 1-9/16", 1-11/16", 1-13/16", and 2-1/16" were discontinued and the 2-1/4" size was added. This elimination reduced inventory since it would only be necessary to stock sizes in 1/8" increments rather than 1/16" increments as before.

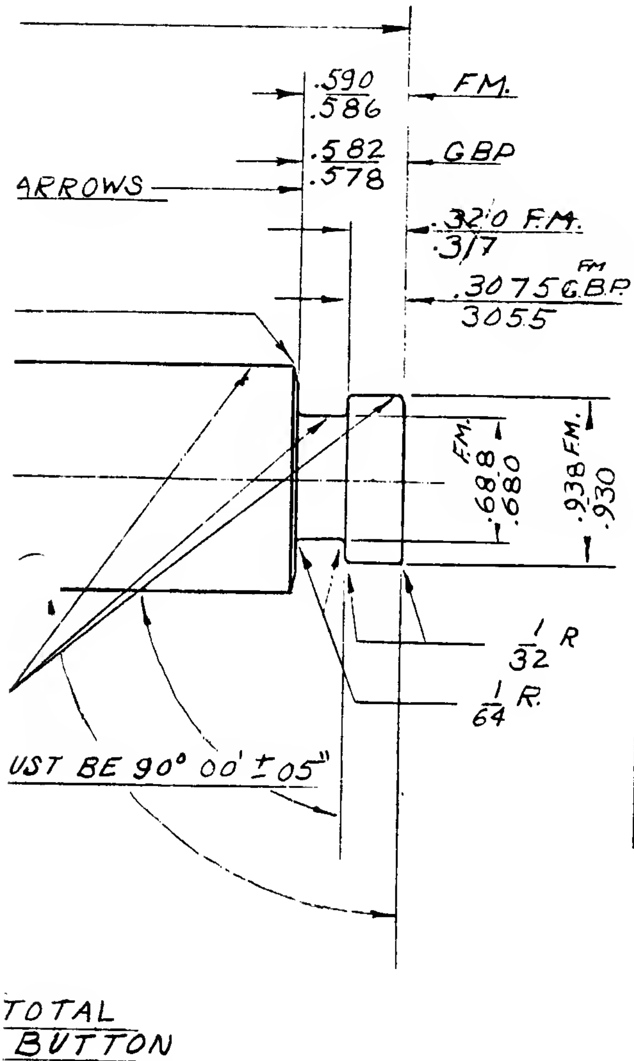
(P22) Was 0.020 radius; changed to 0.030 radius on sizes less than one inch and a 1/8 x 5° chamfer with 0.030 radius on sizes one inch and over. This was another attempt to reduce the chromium buildup at the sharp corners during the electroplating operation.

(P23) Chamfer was 1/8 x 5° x 0.020 radius; changed to a 60° chamfer. Another attempt to reduce chromium buildup.

Exhibit 4 Plunger, Floating (drawing) dated 6-14-44



PART NUMBER	NOM. SIZE	A FINISH MACHINE	B GRIND BEFORE PLATING	C LAP BEFORE PLATING	D LAP AFTER PLATING	MAT'L DIA.
21176	3/4	.757	.751	.7488	.7500	1
21177	7/8	.882	.876	.8638	.8750	1
21178	1	1.007	1.001	.9988	1.0000	1 1/8
21179	1 1/16	1.069	1.063	1.0613	1.0625	1 1/8
21180	1 1/8	1.132	1.126	1.1238	1.1250	1 1/4
21181	1 3/16	1.194	1.188	1.1863	1.1875	1 1/4
21182	1 1/4	1.257	1.251	1.2488	1.2500	1 3/8
21183	1 5/16	1.319	1.313	1.3113	1.3125	1 3/8
21184	1 3/8	1.382	1.376	1.3738	1.3750	1 1/2
21185	1 7/16	1.444	1.438	1.4363	1.4375	1 1/2
21186	1 1/2	1.507	1.501	1.4988	1.5000	1 5/8
21187	1 9/16	1.569	1.563	1.5613	1.5625	1 5/8
21188	1 5/8	1.632	1.626	1.6238	1.6250	1 3/4
21189	1 11/16	1.694	1.688	1.6863	1.6875	1 3/4
21190	1 3/4	1.757	1.751	1.7488	1.7500	1 7/8
21191	1 13/16	1.819	1.813	1.8113	1.8125	1 7/8
21192	1 7/8	2.882	1.876	1.8738	1.8750	2
21193	1 15/16	1.944	1.938	1.9363	1.9375	2
21194	2	2.007	2.001	1.9988	2.0000	2 1/8
21195	2 1/16	2.069	2.063	2.0613	2.0625	2 1/8
21196	2 1/8	2.132	2.126	2.1238	2.1250	2 1/4



SUPERSEDED

OUGH GRIND	FG FIN. GRIND	FL LAP	FH HONE	GBH GRIND BEFORE H.T.	GAH GRIND AFTER H.T.	GBP GRIND BEFORE PLAT.	GAP GRIND AFTER PLAT.	SF SUPER-FIN. TO ____ MICRO-IN.

MAT'L. H.R. STL (S.A.E. 4140) X 10 3/4

INDEX L-A

HEAT TR. - KOBE NO.

SCALE FULL

DRAWN H. J. DATE 5-1-44

CHECKED C. R.O. 5-5-44

APPROVED

LIMITS NOT SHOWN: FRACT. ± 1/64; DECIMAL ± .005; ANGULAR ± 1/4°; CONCEN. WITHIN .005; PARALLEL ± .005 IN 10

PLUNGER, FLOATING
KOBE CHROME PLATED
#3 TRIPLEX

KOBE, INCORPORATED
HUNTINGTON PARK, CALIFORNIA

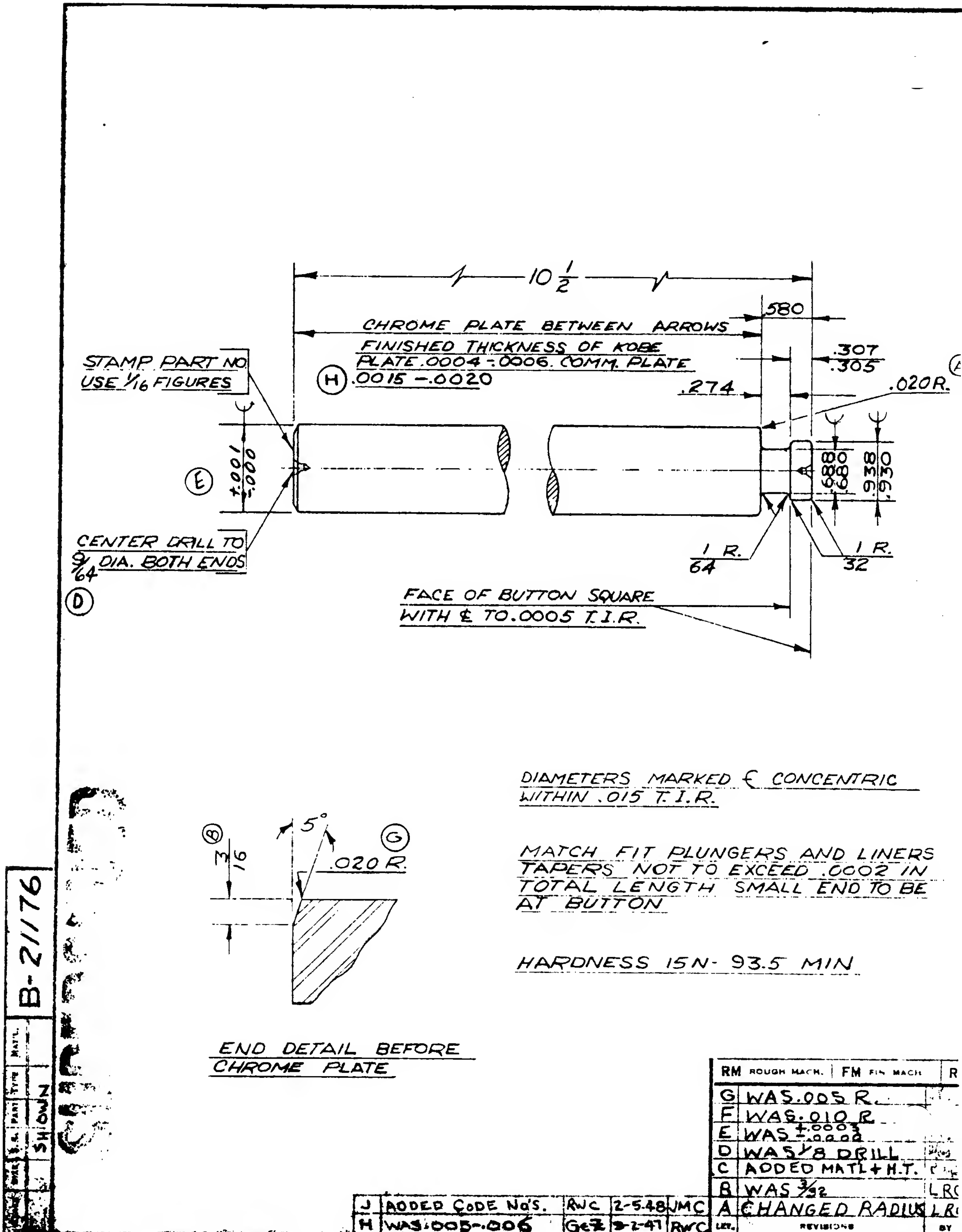
SUPERSEDES | DATE | CH'D.

SUPERSEDED BY A-21176 To 21196 DATE 4-14-44

B-21176 TO 21196 INCL.

DATE | CH'D

Exhibit 5 Plunger, Floating (drawing) dated 3-24-48



MATERIAL LIST

NO. PCS.	DESCRIPTION	CUTS NO.	CUTS LENGTH	MAT'L	PC NO.	DWG. NO.

COMM. CHROME		KOBE CHROME		NOM.	LAP
CODE NO.	DWG NO.	CODE NO.	DWG. NO.	SIZE	
3-36-01-12-91-753	13486	3-36-01-12-91-853	21176	3/4	.7500
3-36-01-14-91-753	13485	3-36-01-14-91-853	21177	7/8	.8750
3-36-01-16-91-753	13100	3-36-01-16-91-853	21178	1	1.0000
3-36-01-17-91-753	13101	3-36-01-17-91-853	21179	1 1/16	1.0625
3-36-01-18-91-753	13102	3-36-01-18-91-853	21180	1 1/8	1.1250
3-36-01-19-91-753	13103	3-36-01-19-91-853	21181	1 3/16	1.1875
3-36-01-20-91-753	13104	3-36-01-20-91-853	21182	1 1/4	1.2500
3-36-01-21-91-753	13105	3-36-01-21-91-853	21183	1 5/16	1.3125
3-36-01-22-91-753	13106	3-36-01-22-91-853	21184	1 3/8	1.3750
3-36-01-23-91-753	13107	3-36-01-23-91-853	21185	1 7/16	1.4375
3-36-01-24-91-753	13108	3-36-01-24-91-853	21186	1 1/2	1.5000
3-36-01-25-91-753	13109	3-36-01-25-91-853	21187	1 9/16	1.5625
3-36-01-26-91-753	13110	3-36-01-26-91-853	21188	1 5/8	1.6250
3-36-01-27-91-753	13111	3-36-01-27-91-853	21189	1 11/16	1.6875
3-36-01-28-91-753	13112	3-36-01-28-91-853	21190	1 3/4	1.7500
3-36-01-29-91-753	13113	3-36-01-29-91-853	21191	1 13/16	1.8125
3-36-01-30-91-753	13114	3-36-01-30-91-853	21192	1 7/8	1.8750
3-36-01-31-91-753	13115	3-36-01-31-91-853	21193	1 15/16	1.9375
3-36-01-32-91-753	13116	3-36-01-32-91-853	21194	2	2.0000
3-36-01-33-91-753	13117	3-36-01-33-91-853	21195	2 1/16	2.0625
3-36-01-34-91-753	13118	3-36-01-34-91-853	21196	2 1/8	2.1250

SUPERSEDED

©

REFERENCE | DWG. NO.

ROUGH GRIND | FG FIN GRIND | FL LAP | GAH GRIND AFTER H.T. | GBP GRIND BEFORE PLAT | GAP GRIND AFTER PLAT | LAP LAP AFTER PLAT

DATE	C'K'D
25-47	JMC
	MC
	JMC
5-47	JMC
14-46	JMC
14-46	JMC
14-46	JMC

MAT'L. N.I.T. EZ KOBE

HEAT TR. KOBE NO. 7

SCALE NONE

DRAWN RDI. DATE 2-7-45

CHECKED

APPROVED

LIMITS UNLESS SHOWN: FRACT. ± 1/64; DECIMAL ± .005; ANGULAR; CONCEN. WITHIN .005; PARALLEL ± .005 IN 10"

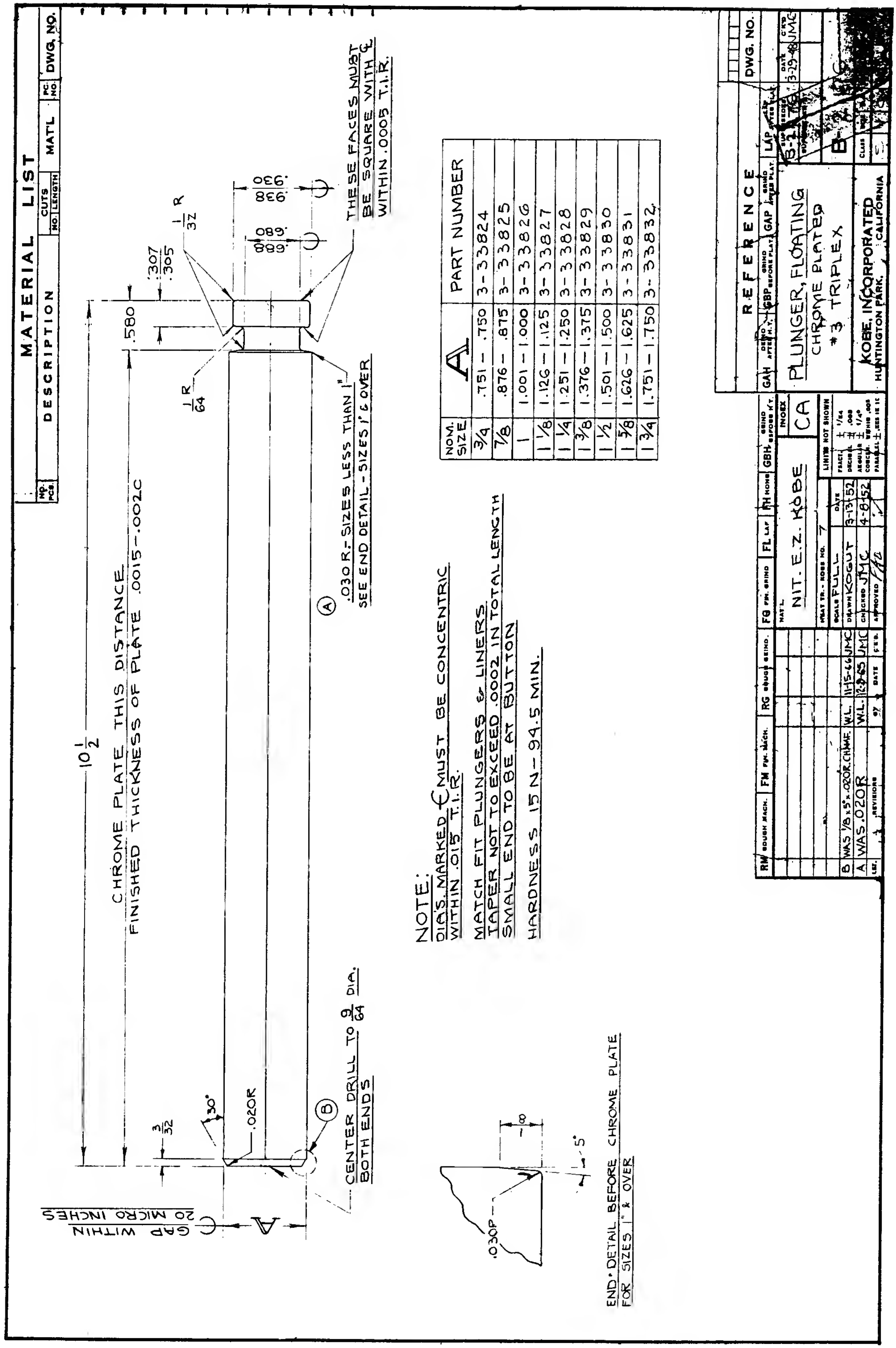
PLUNGER, FLOATING
CHROME PLATED
3 TRIPLEX

KOBE. INCORPORATED
HUNTINGTON PARK. CALIFORNIA

SUPERSEDES A21176

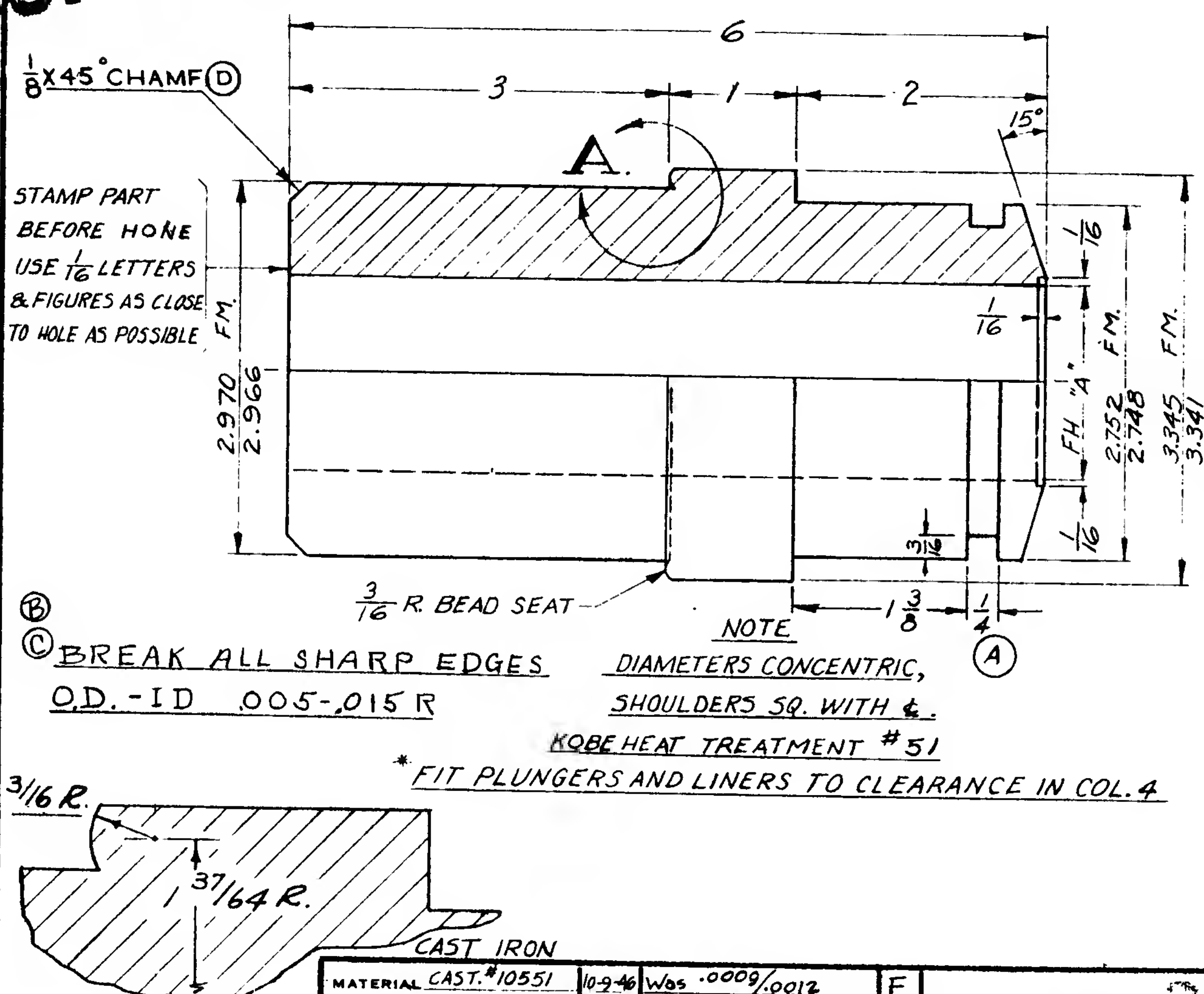
SUPERSEDED BY B-21176 | DATE 3-24-48 | C'K'D JMC

B-21176


MATERIAL LIST
NO. PCS.
DESCRIPTION
CUTS NO. LENGTH
MAT'L
PC. NO.
DWG. NO.
$10\frac{1}{2}$
CHROME PLATE THIS DISTANCE
FINISHED THICKNESS OF PLATE .0015-.002C
.580
.307 .305
$\frac{1}{32}$ R
$\frac{1}{64}$ R
.688 .680
.938 .930
THESE FACES MUST BE SQUARE WITH ℄ WITHIN .0005 T.I.R.
A .030 R.- SIZES LESS THAN 1" SEE END DETAIL - SIZES 1" & OVER
NOM. SIZE
A
PART NUMBER
3/4 .751 - .750 3-33824
7/8 .876 - .875 3-33825
1 1.001 - 1.000 3-33826
1 1/8 1.126 - 1.125 3-33827
1 1/4 1.251 - 1.250 3-33828
1 3/8 1.376 - 1.375 3-33829
1 1/2 1.501 - 1.500 3-33830
1 5/8 1.626 - 1.625 3-33831
1 3/4 1.751 - 1.750 3-33832
NOTE:
DIA'S. MARKED ℄ MUST BE CONCENTRIC WITHIN .015 T.I.R.
MATCH FIT PLUNGERS & LINERS
TAPER NOT TO EXCEED .0002 IN TOTAL LENGTH
SMALL END TO BE AT BUTTON
HARDNESS 15N - 94.5 MIN.
$\frac{3}{32}$
30°
.020R
B CENTER DRILL TO $\frac{9}{64}$ DIA. BOTH ENDS
GAP WITHIN 20 MICRO INCHES
.030R
$\frac{1}{8}$
5°
END DETAIL BEFORE CHROME PLATE FOR SIZES 1" & OVER
REFERENCE
PLUNGER, FLOATING
CHROME PLATED
#3 TRIPLEX
KOBE, INCORPORATED
HUNTINGTON PARK, CALIFORNIA
NIT. E.Z. KOBE
CA
SCALE FULL
DRAWN KOGUT
CHECKED JMC
3-13-52
4-8-52
B WAS 1/8 x 5° x .020R CHAMF. W.L. 11-15-46 JMC
A WAS .020R W.L. 12-9-45 JMC
REVISIONS
3-29-48 JMC

A-10529 TO 10539 INCL.

SUPERSEDED



(B)
(C) BREAK ALL SHARP EDGES
O.D.-ID .005-.015 R

NOTE
DIAMETERS CONCENTRIC,
SHOULDERS SQ. WITH ℄.
KOBE HEAT TREATMENT #51
* FIT PLUNGERS AND LINERS TO CLEARANCE IN COL. 4

NOM. SIZE.	PART NUMBER	BORE DIA. "A" *	PLUNGER CLEARANCE
3/4"	12081	0.7500	.0004 / .0005
13/16"	12108	0.8125	.0004 / .0006
7/8"	10529	0.8750	.0004 / .0006
15/16"	12109	0.9375	.0005 / .0007
1"	10530	1.0000	.0005 / .0007
1 1/16"	12110	1.0625	.0005 / .0007
1 1/8"	10531	1.1250	.0006 / .0008
1 3/16"	12111	1.1875	.0006 / .0008
1 1/4"	10532	1.2500	.0006 / .0009
1 5/16"	12112	1.3125	.0007 / .0010
1 3/8"	10533	1.3750	.0007 / .0010
1 7/16"	12113	1.4375	.0007 / .0010
1 1/2"	10534	1.5000	.0008 / .0011
1 9/16"	12114	1.5625	.0008 / .0010
1 5/8	10535	1.6250	.0008 / .0011
1 11/16"	12115	1.6875	.0008 / .0012
1 3/4"	10536	1.7500	.0009 / .0013
1 13/16"	12116	1.8125	.0009 / .0013
1 7/8"	10537	1.8750	.0009 / .0013
1 15/16"	12117	1.9375	.0010 / .0014
2"	10538	2.0000	.0010 / .0014
2 1/16"	12118	2.0625	.0010 / .0014
2 1/8"	10539	2.1250	.0011 / .0015

(E) (F)

MATERIAL CAST. #10551	10-9-46	Was .0009/.0012	F
FINISH ALL OVER	10-9-46	" .0007/.0009	E
LIMITS	2-6-46	CHAMF. ADDED	D
FRACTIONAL ± 1/64	10/12/45	Added	C
DECIMAL SHOWN	10/12/45	Added	B
SUPERSEDES	3/19/45	GROOVE ADDED	A
SUPERSEDED B-10529	DATE	ALTERATION	No.

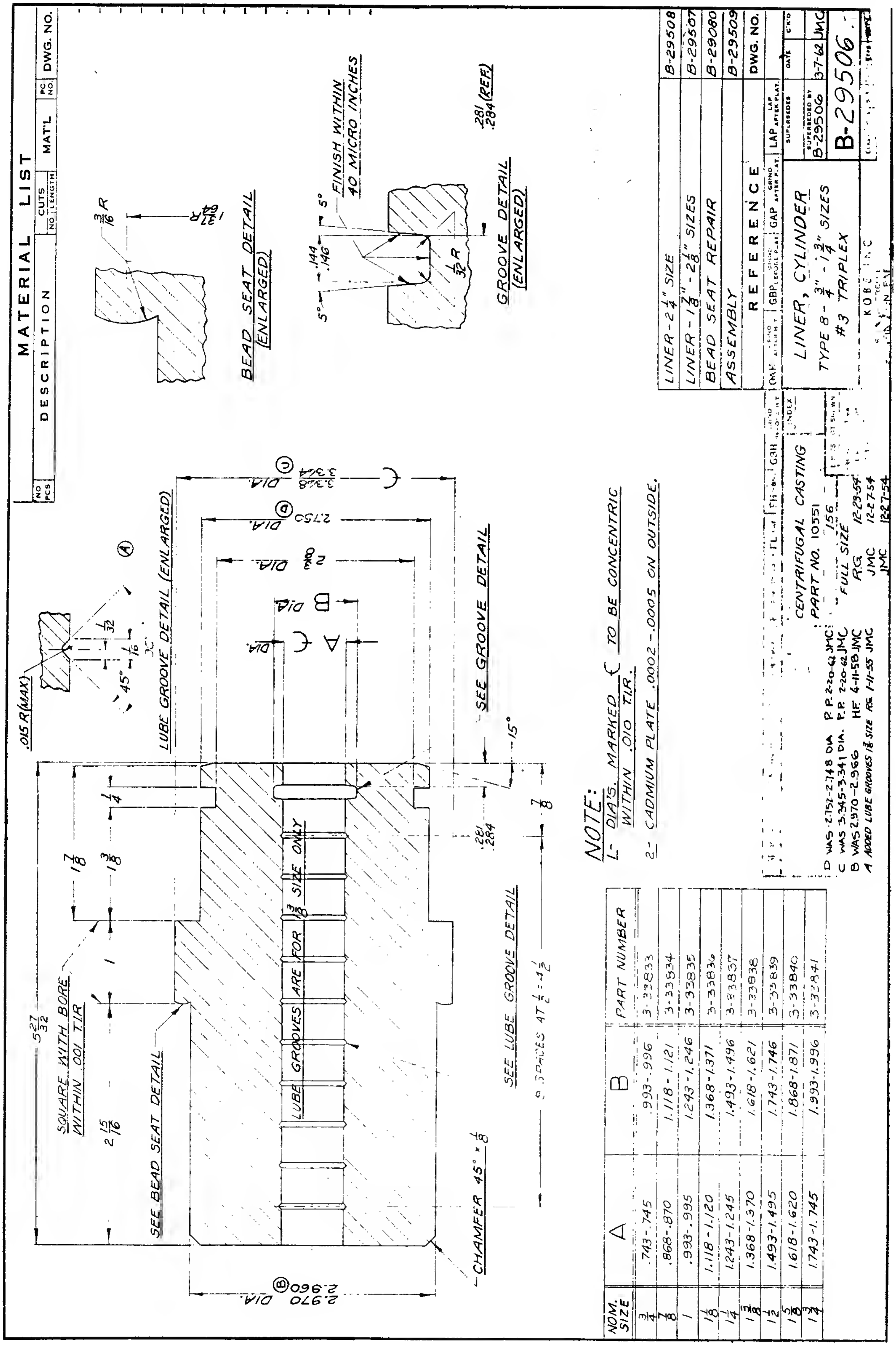
12-4-46

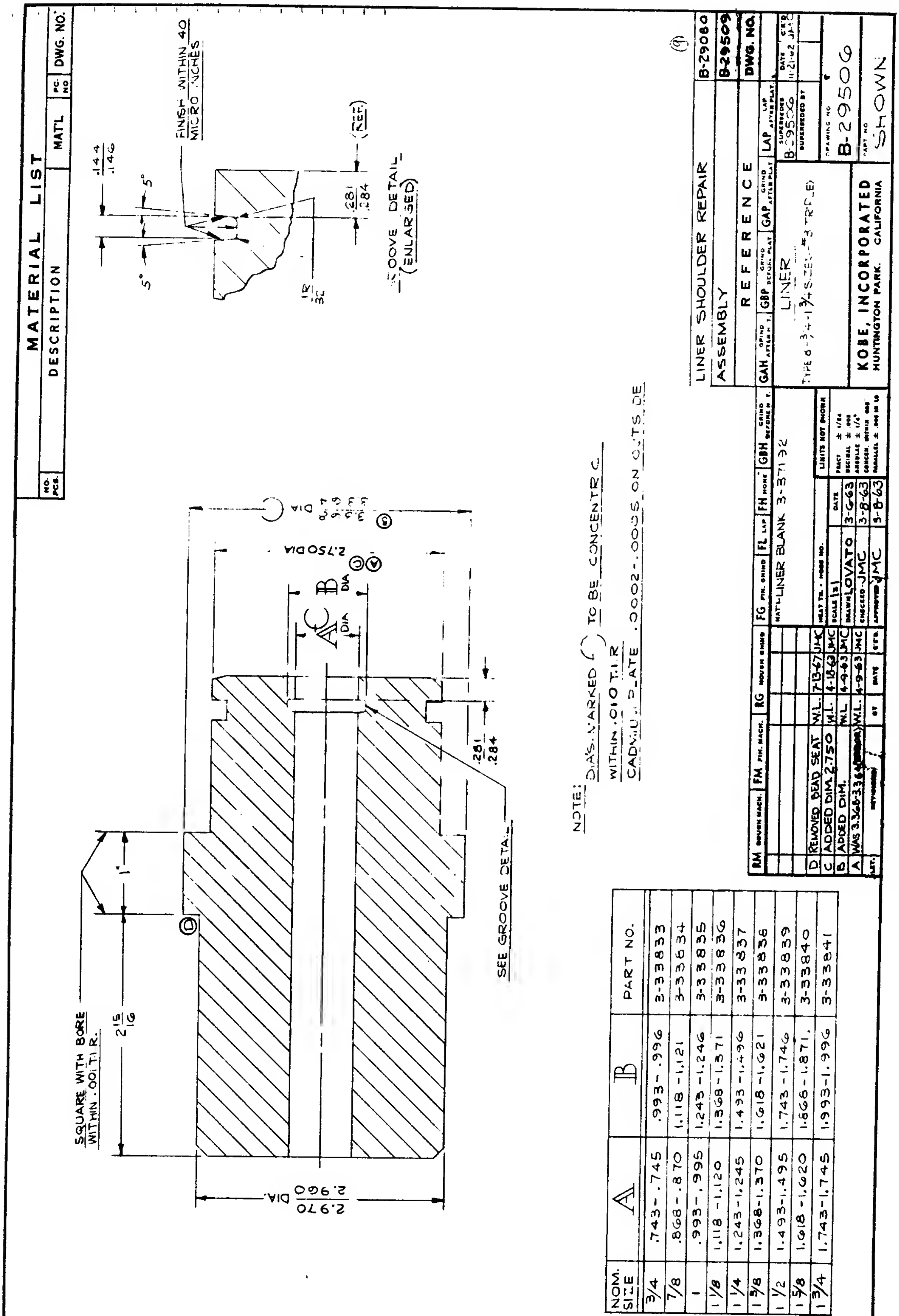
LINER, CYLINDER –
#3 TRIPLEX

BY J.L.B. TR.
CKD. SCALE 3/4
APP. DATE

KOBE. INCORPORATED
HUNTINGTON PARK CALIFORNIA

A 10529 TO 10539 INCL.


MATERIAL LIST
NO PCS
DESCRIPTION
CUTS NO LENGTH
MAT'L
PC NO
DWG. NO.
BEAD SEAT DETAIL (ENLARGED)
FINISH WITHIN 40 MICRO INCHES
GROOVE DETAIL (ENLARGED)
LUBE GROOVE DETAIL (ENLARGED)
.015 R (MAX)
SEE GROOVE DETAIL
SEE LUBE GROOVE DETAIL
SEE BEAD SEAT DETAIL
SQUARE WITH BORE WITHIN .001 T.I.R.
CHAMFER 45° x 1/8
LUBE GROOVES ARE FOR 1 3/8 SIZE ONLY
2.970 2.960 DIA.
2.750 DIA.
3.348 3.344 DIA.
NOTE:
1- DIA'S. MARKED ℄ TO BE CONCENTRIC WITHIN .010 T.I.R.
2- CADMIUM PLATE .0002-.0005 ON OUTSIDE.
NOM. SIZE | A | B | PART NUMBER
3/4 | .743-.745 | .993-.996 | 3-33833
7/8 | .868-.870 | 1.118-1.121 | 3-33834
1 | .993-.995 | 1.243-1.246 | 3-33835
1 1/8 | 1.118-1.120 | 1.368-1.371 | 3-33836
1 1/4 | 1.243-1.245 | 1.493-1.496 | 3-33837
1 3/8 | 1.368-1.370 | 1.618-1.621 | 3-33838
1 1/2 | 1.493-1.495 | 1.743-1.746 | 3-33839
1 5/8 | 1.618-1.620 | 1.868-1.871 | 3-33840
1 3/4 | 1.743-1.745 | 1.993-1.996 | 3-33841
D WAS 2.752-2.748 DIA
C WAS 3.345-3.341 DIA.
B WAS 2.970-2.966
A ADDED LUBE GROOVES 1 3/8 SIZE
CENTRIFUGAL CASTING
PART NO. 10551
FULL SIZE
LINER - 2 1/4" SIZE | B-29508
LINER - 1 7/8" - 2 1/8" SIZES | B-29507
BEAD SEAT REPAIR | B-29080
ASSEMBLY | B-29509
REFERENCE
LINER, CYLINDER
TYPE 8 - 3/4" - 1 3/4" SIZES
#3 TRIPLEX
KOBE INC.
B-29506


MATERIAL LIST
NO. PCS.
DESCRIPTION
MAT'L
PC. NO
DWG. NO.
FINISH WITHIN 40 MICRO INCHES
5°
.144
.146
(REF)
.281
.284
GROOVE DETAIL (ENLARGED)
2.750 DIA
SQUARE WITH BORE WITHIN .001 T.I.R.
1"
2 15/16
2.970
2.960 DIA.
SEE GROOVE DETAIL
NOTE:
DIA'S. MARKED TO BE CONCENTRIC
WITHIN .010 T.I.R
LINER SHOULDER REPAIR
B-29080
ASSEMBLY
B-29509
REFERENCE
DWG. NO.
LINER BLANK 3-37192
LOVATO
JMC
KOBE, INCORPORATED
HUNTINGTON PARK. CALIFORNIA
B-29506
SHOWN
NOM. SIZE | A | B | PART NO.
3/4 | .743-.745 | .993-.996 | 3-33833
7/8 | .868-.870 | 1.118-1.121 | 3-33834
1 | .993-.995 | 1.243-1.246 | 3-33835
1 1/8 | 1.118-1.120 | 1.368-1.371 | 3-33836
1 1/4 | 1.243-1.245 | 1.493-1.496 | 3-33837
1 3/8 | 1.368-1.370 | 1.618-1.621 | 3-33838
1 1/2 | 1.493-1.495 | 1.743-1.746 | 3-33839
1 5/8 | 1.618-1.620 | 1.868-1.871 | 3-33840
1 3/4 | 1.743-1.745 | 1.993-1.996 | 3-33841

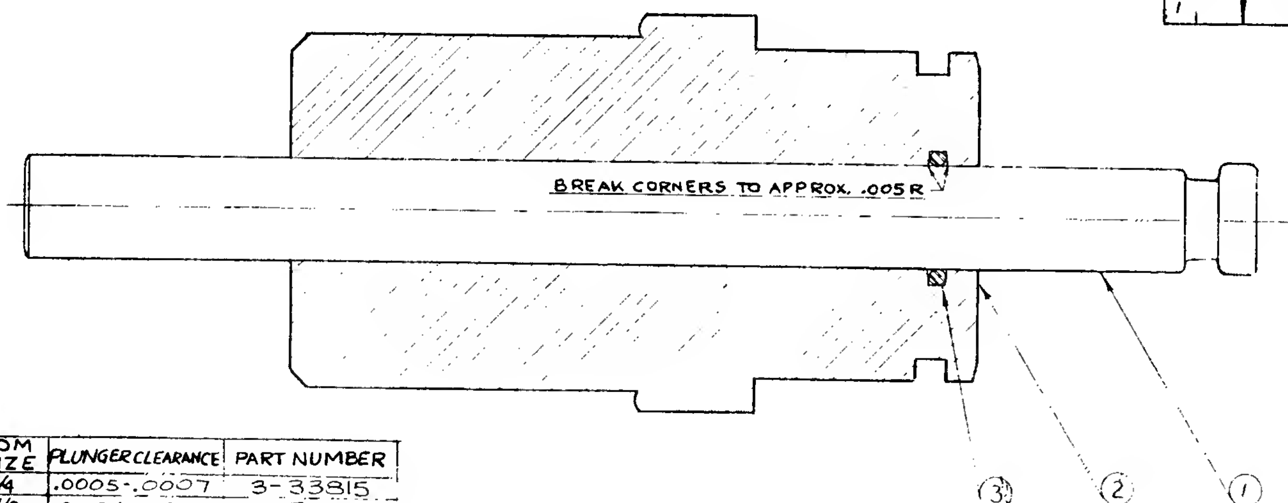
APRIL 22, 1952

NOM SIZE	PLUNGER CLEARANCE	PART NUMBER
3/4	.0003-.0005	3-36-01-12-01-700
7/8	.0004-.0006	3-36-01-14-01-700
1	.0005-.0007	3-36-01-16-01-700
1 1/8	.0006-.0008	3-36-01-18-01-700
1 1/4	.0006-.0009	3-36-01-20-01-700
1 3/8	.0007-.0010	3-36-01-22-01-700
1 1/2	.0008-.0011	3-36-01-24-01-700
1 5/8	.0008-.0011	3-36-01-26-01-700
1 3/4	.0009-.0013	3-36-01-28-01-700
1 7/8	.0009-.0013	3-36-01-30-01-700
2	.0010-.0014	3-36-01-32-01-700
2 1/8	.0011-.0015	3-36-01-34-01-700
2 1/4	.0011-.0015	3-36-51-36-01-001

1	"O" RING (1 5/8 SIZE)	6230-1	PARCO 419-90	3
1	(1 3/4 SIZE)	6230-2		3
1	(1 7/8 SIZE)	6230-3		3
1	(2 SIZE)	6230-4		3
1	(2 1/8 SIZE)	6230-5		3
1	(2 1/4 SIZE)	6230-6		3

MATERIAL LIST

NO. PCS.	DESCRIPTION	CUTS NO.	CUTS LENGTH	MAT'L	PC. NO.	DWG. NO.
1	PLUNGER (3/4 - 1 3/4 SIZES)				1	B-21176
1	(1 7/8 SIZE)				1	B-26011
1	(2" SIZE)				1	B-25919
1	(2 1/8 SIZE)				1	B-25915
1	(2 1/4 SIZE)				1	B-23843
1	LINER (3/4 - 1 3/4 SIZES)				2	B-29506
1	(1 7/8 - 2 1/8 SIZES)				2	B-29507
1	(2 1/4 SIZE)				2	B-29508
1	"O" RING (3/4 SIZE) 6227-15			PARCO 419-90	3	
1	(7/8 SIZE) 6227-17				3	
1	(1 SIZE) 6227-19				3	
1	(1 1/8 SIZE) 6227-21				3	
1	(1 1/4 SIZE) 6227-23				3	
1	(1 3/8 SIZE) 6227-25				3	
1	(1 1/2 SIZE) 6227-27				3	



SUPERSEDED

NOM SIZE	PLUNGER CLEARANCE	PART NUMBER
3/4	.0005-.0007	3-33815
7/8	.0006-.0008	3-33816
1	.0007-.0009	3-33817
1 1/8	.0008-.0011	3-33818
1 1/4	.0008-.0011	3-33819
1 3/8	.0008-.0011	3-33820
1 1/2	.0008-.0011	3-33821
1 5/8	.0008-.0011	3-33822
1 3/4	.0008-.0011	3-33823
1 7/8	.0008-.0011	3-33862
2	.0008-.0011	3-33863
2 1/8	.0009-.0012	3-33864
2 1/4	.0009-.0012	3-33865

RM ROUGH MACH. | FM FIN MACH. | RG ROUGH GRIND | FG FIN. GRIND | FL LAP | FH HONE | GBH GRIND BEFORE H.T. | GAH GRIND AFTER H.T. | GBP GRIND BEFORE PLAT. | GAP GRIND AFTER PLAT. | LAP LAP AFTER PLAT.

MAT'L — INDEX

HEAT TR. / KOBE NO.

SCALE: 1=1
DRAWN W.L. 6-3-63
CHECKED JMQ 6-3-63
APPROVED JMQ 6-3-63

LIMITS NOT SHOWN
FRACT. ± 1/64
DECIMAL ± .005
ANGULAR ± 1/4°
CONCEN. WITHIN .005
PARALLEL ± .005 IN 12

#3 TRIPLEX ASSEMBLY D-29073

REFERENCE DWG. NO.

PLUNGER & LINER SUB-ASS'Y
TYPE 3 ALL SIZES
#3 TRIPLEX

SUPERSEDES B-29509 DATE 12-27-54 CK'D JMC
SUPERSEDED BY B-29509 7-2-64

B-29509

KOBE INC.
DIVISION OF DRESSER EQUIPMENT CO.
HUNTINGTON PARK, CALIFORNIA